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POTASH DEFICIENCY IN TEA

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Apart from the intrinsic interest of the following article, it is especially notable by reason of the fact that it includes the first colour plates used to illustrate an article in this journal. The advantages of coloured illustrations, especially for pathological subjects, are manifold and it is hoped that the high cost of colour plates will not prohibit their use, to a limited extent, in future publications. On this occasion, the whole cost of the colour plates has been borne by Kalivertriebsstelle G.M.B.H. of Hannover and we are greatly indebted to them for this generous contribution as well as to their representative, Dr. Piekenbrock, who took the original photographs.

The analytical data used in the article were culled from an extensive series of leaf analyses planned by Dr. Haworth during his period of service as Agricultural Chemist. The use of the data has been delayed and complicated by Dr. Haworth's resignation, but their usefulness is clearly demonstrated by Mr. Portsmouth's interpretation.

In 1950 I published an article in this journal dealing with the potash requirements of tea[1]. In this article I briefly reviewed the results of the main St. Coombs three factor manurial experiment, in so far as they related to potash, up to the end of the sixth cycle in 1949. By that time the responses, in terms of yield per pound of applied fertiliser, to potash manuring had already reached similar levels to those given by nitrogen manuring. Now, at the end of the seventh cycle of this experiment, the potash responses are greatly in excess of the nitrogen responses, as can be seen from the respective yield figures given in Tables 1 and 2.

Table 1. *St. Coombs Manurial Experiment. Dry Matter Yields for Potash Treatments (Lbs. per acre).*

Cycle years	Treatment	1st year		2nd year		3rd year		Cycle	
		Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase
1949-52 Cycle 7	K_0	226		682		571		1479	
	K_{20}	299	+ 73	884	+ 202	712	+ 141	1895	+ 416
	K_{40}	306	+ 80	909	+ 227	761	+ 190	1976	+ 497

Table 2. *St Coombs Manurial Experiment. Dry Matter Yields for Nitrogen Treatments. (Lbs. per acre).*

Cycle years	Treatments	1st year		2nd year		3rd year		Cycle	
		Yield	Increase	Yield	Increase	Yield	Increase	Yield	Increase
1949-52 Cycle 7	N_{40}	264		759		573		1596	
	N_{60}	276	+ 12	812	+ 53	675	+ 102	1763	+ 167
	N_{80}	291	+ 27	904	+ 145	796	+ 223	1991	+ 395

Considering only the first increment of 20 lbs. fertiliser per acre, it will be seen that, over the three year cycle, the potash response is 416 lbs. of made tea and the equivalent nitrogen response 167 lbs. made tea. This represents a return of 6.9 lbs. of made tea for each pound of potash applied, compared with a return of only 2.8 lbs. for each pound of nitrogen applied.

At the higher treatment levels the difference in response is rather less marked, indicating that a further increase in the potash response at the K_{40} level may still be expected in the future. Whether or not further response increases do occur, it is abundantly clear that potash has now taken over the position, once held by nitrogen, of being the dominant fertiliser treatment in the experiment.

In my previous article I made the point that the increase in yield brought about by potash manuring may also be taken to represent the loss in crop resulting from an absence of potash in the manure. From this view point it is obvious, from Table 1, that lack of potash has resulted in a loss of crop of some 497 lbs. per acre over the cycle, which represent a reduction in yield by 25 per cent.

That the plots, which have received no potash for over 22 years, are now suffering severely from this cause is evident from the marked increase in potash deficiency symptoms which have become apparent during the last two cycles. The present extent and effects of potash deficiency in these K_0 plots are well brought out in the accompanying coloured plates, which have been very kindly presented to the *Tea Quarterly* by the German potash organisation, Kalivertriebsstelle G.M.B.H. of Hannover. These plates were printed in Germany from photographs taken by Dr. A. P. Piekenbrock, of Kalivertriebsstelle G.M.B.H., when he visited St. Coombs in August 1951. Dr. Piekenbrock was greatly impressed by what he saw and felt that these striking effects of potash deficiency in tea were worthy of first class reproduction in colour. To Dr. Piekenbrock's enthusiasm and Kalivertriebsstelle's generosity the *Tea Quarterly* therefore owes its first set of plates in full colour.

The effects of potash deficiency illustrated are briefly as follows:—

(1) Many vacancies, due to deaths of badly potash deficient bushes following recent prunes.

(2) Continued shedding of the lower leaves, resulting in bushes which carry only a few leaves at the top of each branch. Bushes of this general type can be clearly seen in the first and fourth picture.

(3) Thin twiggy wood.

(4) Almost complete absence of any new flush growth.

(5) Pronounced marginal scorch on many of the leaves still remaining on the bushes, as can be clearly seen in the second, fifth and sixth pictures. This is probably a completely diagnostic symptom of potash deficiency in tea, but is not often seen as the leaves are usually shed before it appears.

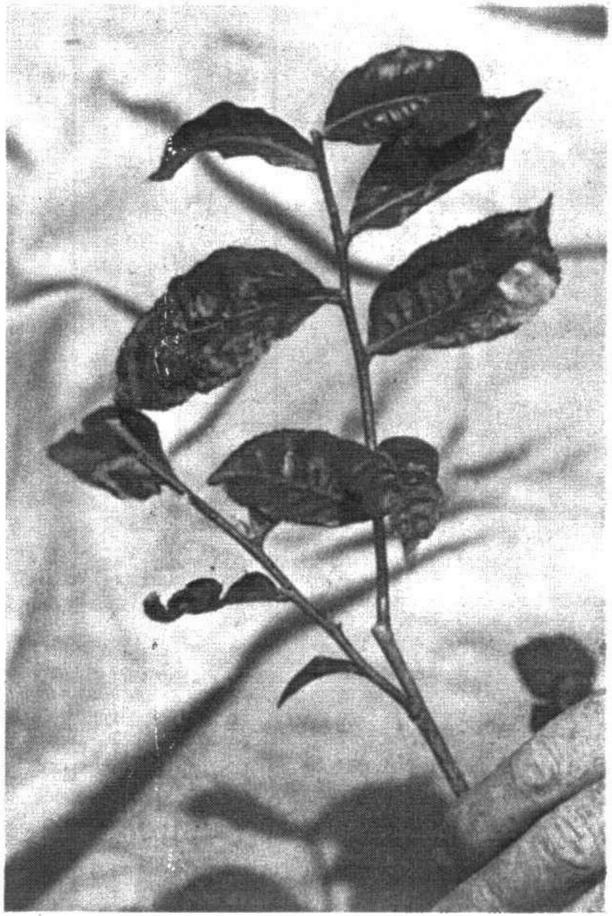
That these effects are, in fact, due to lack of potash is confirmed by the results of a series of leaf analyses recently carried out by the Agricultural Chemistry Department. Two bushes in each plot of the experiment were allowed to rest from the end of October 1951. After 7 months resting, these bushes were cut across at the old plucking level, at the end of May 1952, and the pruned shoots divided into leaves and stems. It should be noted that these leaf samples contained leaves up to 7 months old and thus do not correspond with the plucked flush samples, for which potash analyses have been given previously. However, for convenience, they will be designated New Leaf Samples. At the same time as these samples were taken,

Left NP, right NPK mixture: note effect of lack of potash in manure mixture, many vacancies; also lack of maintenance foliage on the surviving bushes

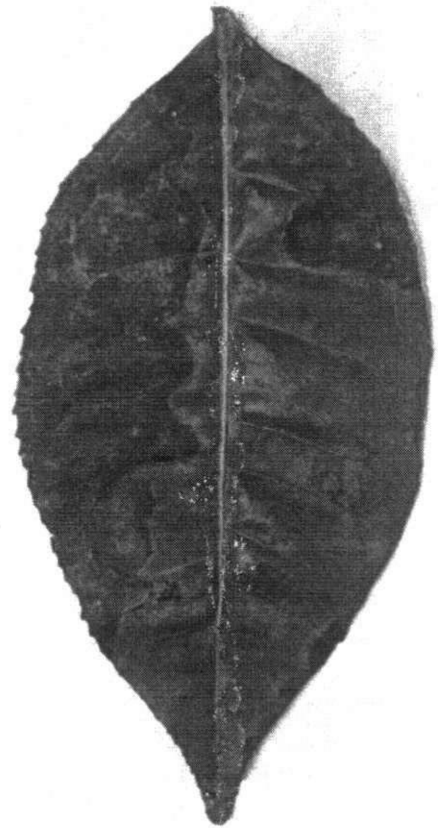
Typical bush on the no potash plot: Note the general debilitated appearance of the bush; thin branches, poor foliage

Fully supplied with potash: Note that the bushes cover the ground completely. Adequate foliage, no vacancies

No potash plot: Note thin wood and poor foliage on surviving bushes; many bushes have died



Shoot from bush on the no potash plot showing marginal scorch on mature leaves



Leaf from typical debilitated bush showing pronounced marginal scorch a sample consisting of 50 old maintenance leaves, was collected from below the cut-across level from each bush. These samples consisted entirely of comparatively old foliage and will, therefore, be designated Old Leaf Samples.

After oven drying all these leaf samples were finely ground and analysed individually for potash, calcium, magnesium and phosphoric acid. The collected results of these analyses, expressed as percentages of the dry weight, are given in Table 3 and 4.

Table 3. *St. Coombs Manurial Experiment. Chemical analysis of New Leaf Samples. (Results expressed as percentages of the dry weight.)*

Treatment level	K_0	K_{20}	K_{40}	Mean
Potash as K_2O	0.73	1.10	1.35	1.06
Calcium as CaO	2.47	2.27	1.97	2.24
Magnesium as MgO	0.63	0.45	0.44	0.51
Total (K_2O + CaO + MgO)	3.83	3.82	3.76	3.80
Phosphoric acid as P_2O_5	0.40	0.41	0.40	0.40

Table 4. *St. Coombs Manurial Experiment. Chemical analysis of Old Leaf Samples (Results expressed as percentages of the dry weight)*

Treatment level	K_0	K_{20}	K_{40}	Mean
Potash as K_2O	0.58	1.14	1.50	1.07
Calcium as CaO	3.07	2.98	2.52	2.86
Magnesium as MgO	0.76	0.50	0.46	0.57
Total (K_2O + CaO + MgO)	4.41	4.62	4.48	4.50
Phosphoric acid as P_2O_5	0.36	0.34	0.34	0.35

From the figures it is obvious that the potash content of the leaf is completely dependent on the amount of potash applied as fertiliser. In the new leaf series the potash content of the leaves from the K_0 plots is only about half that of the leaves from the K_{40} plots. In the old leaf series the range of potash contents is even wider, since the leaves from the K_0 plots show little more than one third of the amount of potash found in the leaves from the K_{40} plots. In the face of this very strong chemical evidence there can be little doubt remaining that the effects observed in the K_0 plots are entirely due to true potash deficiency.

It is worth noting that in both series of samples the total content of potash, calcium and magnesium is approximately constant. This means that where potash is in short supply the deficit is made up by means of an increased uptake of calcium and magnesium, with the result that the salt content of the bush is kept the same. However, it is obvious, from the yield figures and the marked symptoms developed as a result of potash deficiency, that neither calcium nor magnesium is capable of replacing potassium in the many physiological functions it fulfils within the bush.

The constancy of the phosphoric acid contents, given in the bottom lines of Tables 3 and 4, indicates the absence of any form of interaction between potash and phosphoric acid uptakes.

In conclusion I should like to express my thanks to Dr. F. Haworth for initiating this very extensive system of leaf sampling and chemical analysis.

REFERENCE

(1) Portsmouth, G.B.—Potash Requirements of Tea. *Tea Quarterly*, XXI, Pt. 1, p. 18, March, 1950.